The main objectives of this course are:

- Paradigms concurrency, parallel and distributed systems: (client-server, load sharing, tasks, etc.)
340384 - PACO-I5001 - Parallelism and Concurrence

- Platforms parallel (shared memory architectures, distributed memory).
- Tools to aid the development of parallel programs
- Programming and evaluation of parallel programs (programming models for different parallel platforms).
- Memory Coherence and consistency. Communication sincronizació, race conditions, mutex, critical section, monitors, deadlock.

**Study load**

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group:</th>
<th>45h</th>
<th>30.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours medium group:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>Hours small group:</td>
<td>15h</td>
<td>10.00%</td>
</tr>
<tr>
<td></td>
<td>Guided activities:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>Self study:</td>
<td>90h</td>
<td>60.00%</td>
</tr>
</tbody>
</table>
## Content

### 1. Introduction to parallelism

**Learning time:** 9h  
Theory classes: 1h  
Practical classes: 2h  
Self study: 6h

**Description:**  
Need of parallelism. Parallelism versus concurrency. Problems using concurrency: deadlock, lifelock, starvation, fairness, data races

**Related activities:**  
Activity 1. Unit 1 problems  
Activity 2. Lab 0: Experimental setup, tools and programming model

### 2. Analysis of parallel applications

**Learning time:** 11h  
Theory classes: 1h  
Practical classes: 2h  
Laboratory classes: 2h  
Self study: 6h

**Description:**  
Can a computation be divided into different parts? It is divided based on the tasks to do or based on the input/output data.  
Will there be dependence of data between the tasks? How will they be solved? A good decomposition determines the parallel degree achievable.

**Related activities:**  
Activity 1. Problems: Analysis of parallel applications  
Activity 2: Lab 0: Experimental setup, tools and programming model
<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Related activities</th>
<th>Learning time: 20h</th>
</tr>
</thead>
</table>
| 3. Introduction to (shared-memory) Parallel Architectures | Parallelism inside a processor (IDLP, DLP, TLP), multiprocessors with share memory, multiprocessors with distributed memory. | Activity 1. Unit 3 problems  
Activity 2. Lab 0: Experimental setup, tools and programming model  
Activity 4. Knowledge test | Theory classes: 2h  
Practical classes: 4h  
Laboratory classes: 2h  
Self study : 12h |

Activity 2. Lab 1: Embarrassingly parallelism with OpenMP: Mandelbrot set | Theory classes: 2h  
Practical classes: 4h  
Laboratory classes: 2h  
Guided activities: 2h  
Self study : 12h |
### 5. Programming with shared memory

**Learning time:** 31h
- Theory classes: 3h
- Practical classes: 6h
- Laboratory classes: 2h
- Guided activities: 2h
- Self study: 18h

**Description:**
Parallel regions, threads, and tasks. Task threads, barriers, mutual exclusion locks. Work distributors: loops, sections.

**Related activities:**
- Activity 1. Share memory problems
- Activity 2. Lab 2: Divide and Conquer parallelism with OpenMP: Sorting
- Activity 3. Directed work. Additional practice

### 6. Basics of parallel programming: Data decomposition

**Learning time:** 31h
- Theory classes: 3h
- Practical classes: 6h
- Laboratory classes: 4h
- Self study: 18h

**Description:**
Data decomposition (geometric versus recursive structure), data flow organization (regular versus irregular). Mechanisms to implement the data decomposition: creation and destruction process, process synchronization (barrier) and communications patterns (point-to-point communication, synchronous and asynchronous communication)

**Related activities:**
- Activity 1. Data decomposition problems
- Activity 2. Lab 3: Geometric decomposition: solving the heat equation

### Qualification system

Partial knowledge test * 0.2 + problems * 0.2 + 0.2 * Laboratory + complementary * 0.1 + Working knowledge 2nd part test * 0.3 > = 5

### Regulations for carrying out activities

Activities 1, 2 and 4 are in person. Activity 3 is non-attendance, although there may be a short presentation in class. In the activities that take place in group, the mark will be the same for all group members.
Bibliography

Basic:


Others resources:

Software a Boada

Connection and software in boada.ac.upc.edu